Docket No. SA-537

Exhibit No. 6-AC

NATIONAL TRANSPORTATION SAFETY BOARD

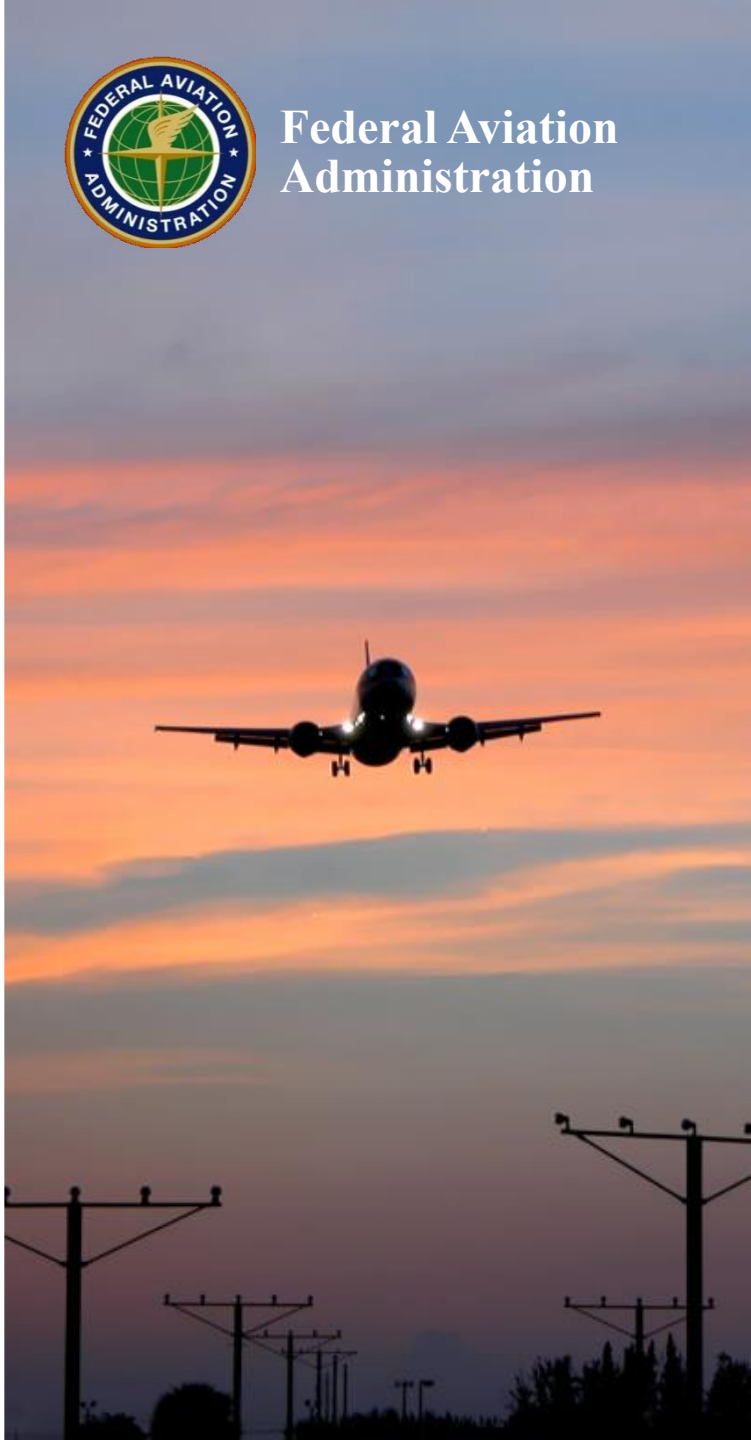
Washington, D.C.

FAA Presentation II
Airplane Cabin Crashworthiness & Occupant Protection

(15 Pages)

Crash Safety Requirements for Aircraft Seats

Federal Aviation Administration



Presented to: NTSB

By: Richard DeWeese, Civil Aerospace Medical Institute

Date: December 11, 2013

Safety Requirements

- **The FAA has established safety requirements for aircraft seats intended to reduce the risk of injury in a severe, but survivable crash**
- **Requirements consist of:**
  - Static load factors applicable to most interior components
  - Dynamic tests to verify seat strength and occupant impact protection
  - Design requirements for specific seat configurations

Static Load Factors

- First required for new designs in 1946
- Intended to protect occupants in a minor crash landing
- Expressed in terms of multiples of an item's weight (commonly referred to as Gs)
- Magnitude varies by load direction and has been increased over the years as aircraft technology changed

Static Load Factors

Static Load Factors for Transport Aircraft

Direction Relative to Aircraft	Factor
Forward	9.0
Sideward	4.0
Upward	3.0
Downward	6.0
Rearward	1.5

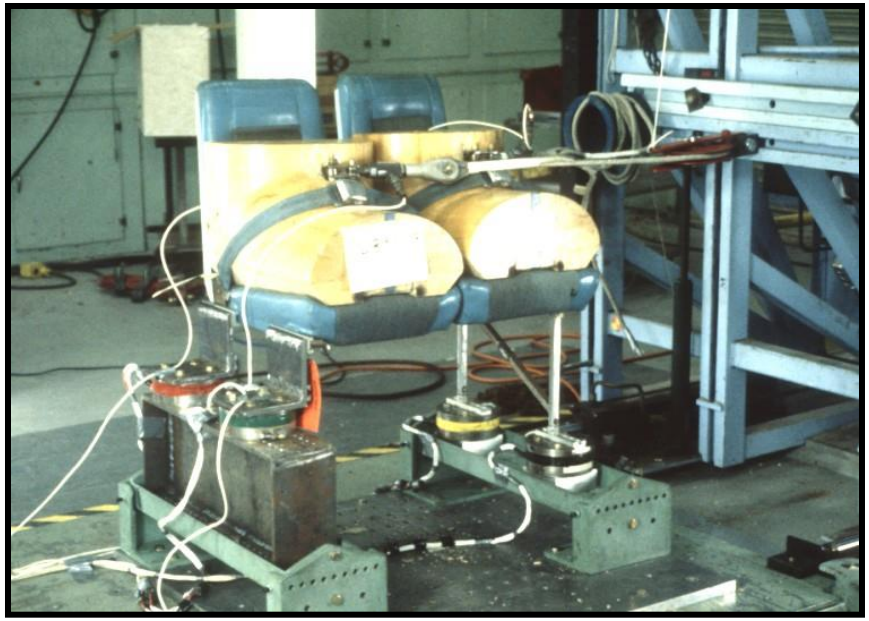
– The strength of seat and belt attachment fittings must be 1.33 times the ultimate loads specified (except for the Sideward direction)

Static Load Factors

- **Strength of seats and restraints verified by tests that apply loads slowly**

Forward Test

Sideward Test

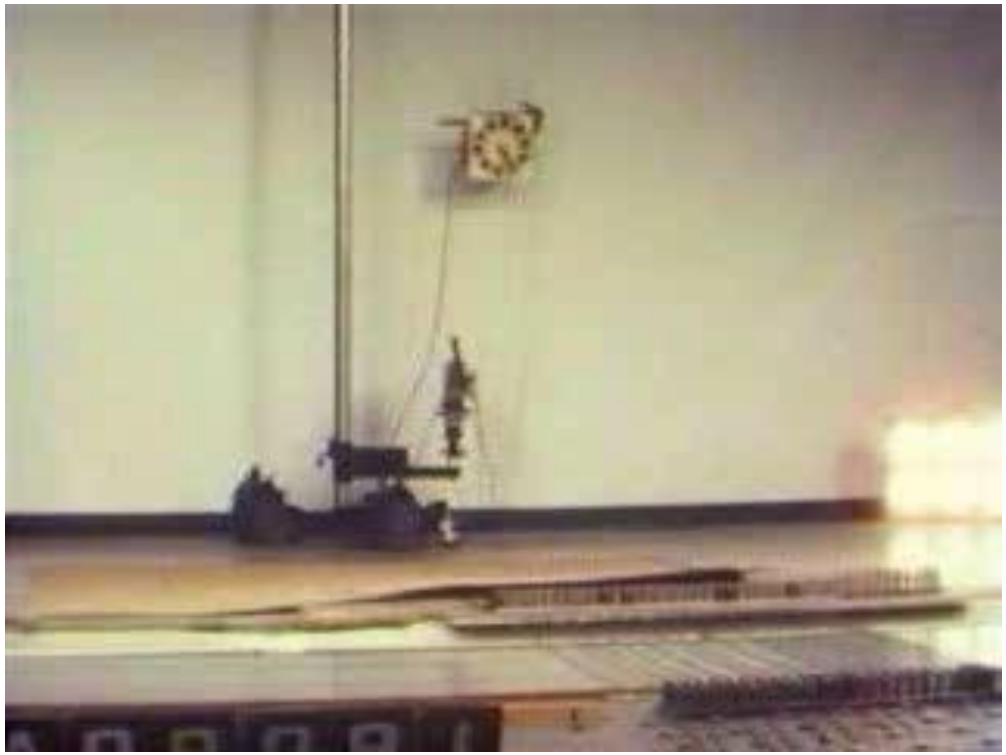


Performance of Statically Qualified Seats

- **Accident studies indicated that survivable crashes can exceed the severity level corresponding to the required static load factors**
  - Predominant force vectors in cases studied were forward and combined vertical/forward directions
  - Dynamic tests confirmed that seats designed to meet only static load factors did not provide a high level of safety in severe, but survivable impacts

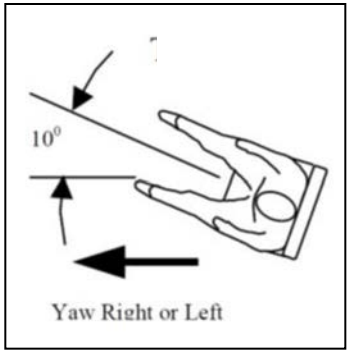
Performance of Statically Qualified Seats

Many seats designed to meet static load factors did not preform well when tested dynamically



Dynamic Test Requirements

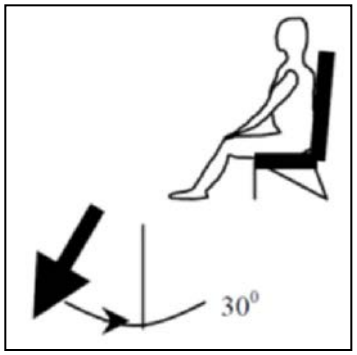
- **Requirements evaluate occupant protection in the two most likely impact scenarios**



Direction: Horizontal at 10 degrees yaw, deformed floor

Severity: 16 G peak acceleration, 44 ft/sec velocity

Impact components: 15.8 G Forward, 2.8 G Sideward



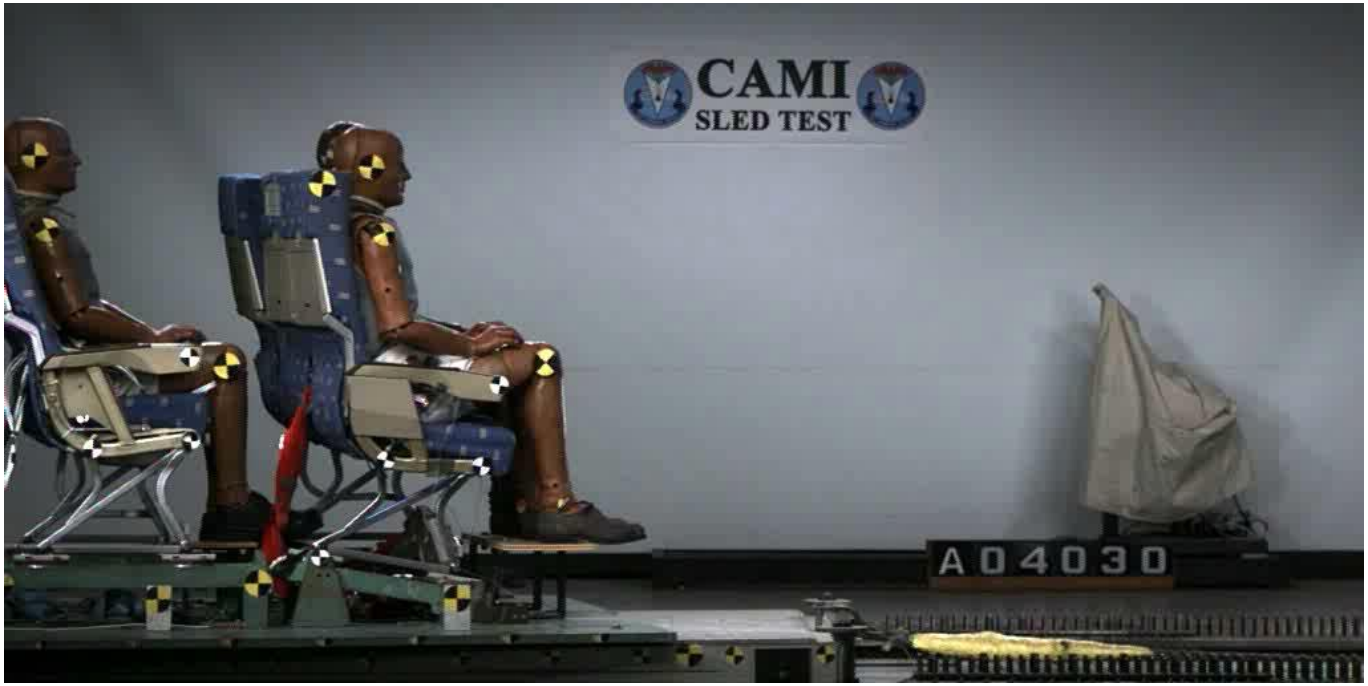
Direction: Combined Vert / Horiz at 30 degrees pitch

Severity: 14 G peak acceleration, 35 ft/sec velocity

Impact components: 12.1 G Vertical, 7.0 G Forward

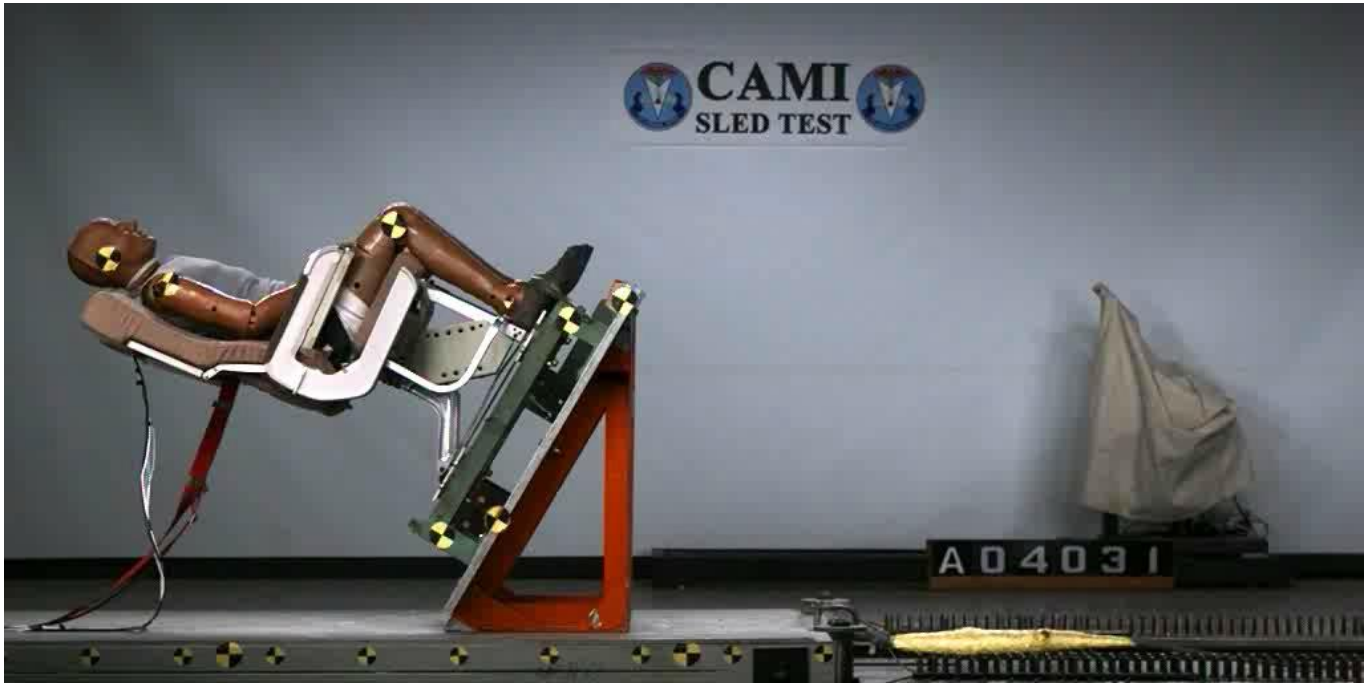
Dynamic Test Requirements

Horizontal orientation, 10 degree yaw, deformed floor. Evaluates seat strength and flexibility, along with head, chest, and leg injury protection



Dynamic Test Requirements

Combined vertical/horizontal orientation (30 degrees from vertical). Evaluates seat strength and spine injury protection



Dynamic Test Requirements

- **In both tests, Anthropomorphic Test Devices (test dummies) are used as occupants**
  - Provide realistic loading for the seat and restraints
  - Instrumented to provide a quantitative assessment of injury severity
- **A poorly performing restraint system can be a source of injury**
  - Position over the body is monitored during the test to ensure it stays in proper position
  - Shoulder belt tension is limited to specific levels

Dynamic Test Requirements

- **Test measurements are related to injury risk using the Injury Criteria summarized below**

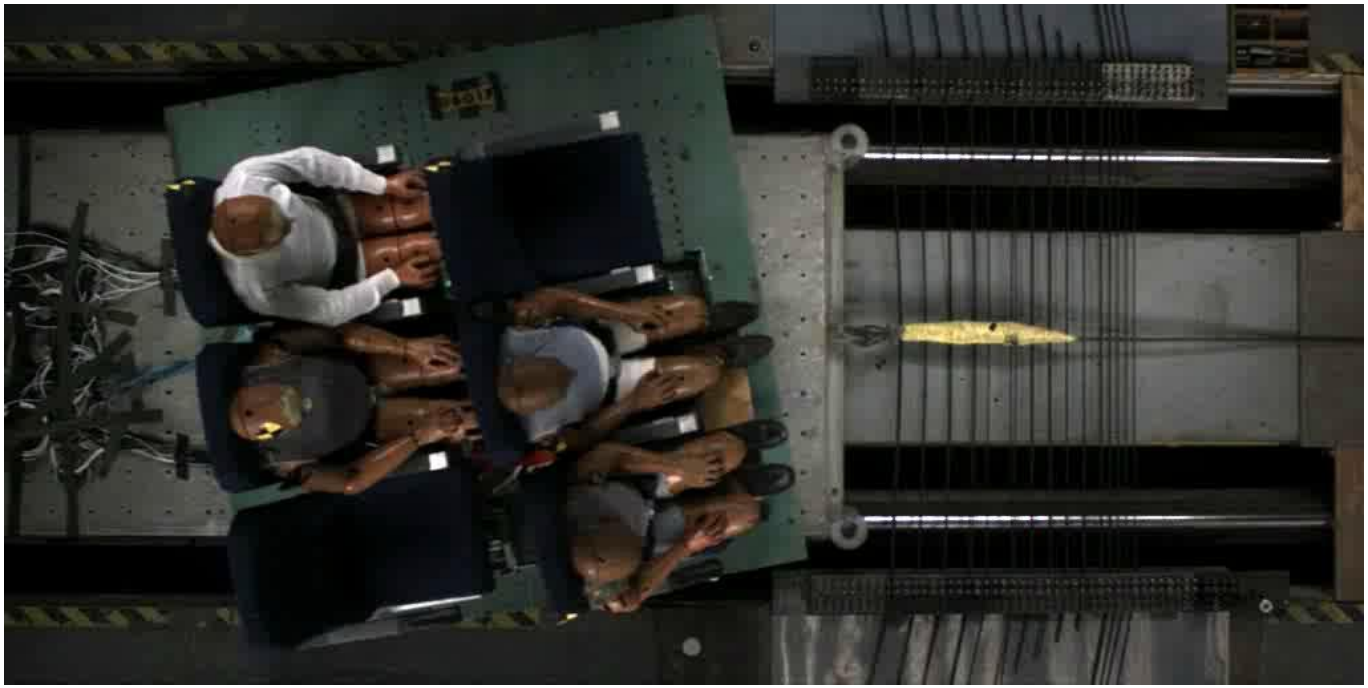
Parameter	Injury Criteria
Head Injury Criteria (HIC)	1000
Shoulder Harness Loads	1750 lb single strap 2000 lb dual strap
Lumbar Spine Load	1500 lb
Femur Load (axial)	2250 lb

Maintaining the Level of Safety

- **New types of seats and restraint systems that were not specifically addressed by the original requirements must provide an equivalent level of safety when compared to standard seats and restraints**
  - Research conducted to derive appropriate requirements
  - Special Conditions issued by the FAA to implement new requirements

Maintaining the Level of Safety

Inflatable Restraints (belt mounted airbags) are an example of a new technology that was addressed by issuance of Special Conditions



Applicable Regulations

- 14 CFR 25.561 Emergency Landing Conditions – General
- 14 CFR 25.562 Emergency Landing Dynamic Conditions
- 14 CFR 25.785 Seats, berths, safety belts, and harnesses
- 14 CFR 121.311 Seats, safety belts, and shoulder harnesses